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## Ethylene Explosion

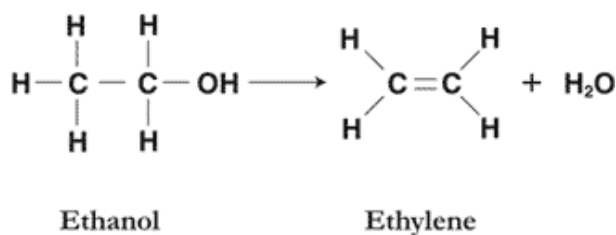
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### Ethylene Explosion - Banana Ripening

The ripening of bananas is accelerated by low concentrations of ethylene, on the order of 0.1% by volume. The lower explosive limit (LEL) for ethylene is 2.7% - therefore the risk of fire or explosion should be very low if proper controls are in place. In the ripening process, bananas are closely stacked in individual rooms and then ethylene is introduced. The typical exposure time is about 24 hours.

Two common ways to introduce ethylene include high-pressure gas cylinders and ethylene generators. The ethylene generators convert ethanol into ethylene by a catalytic process.



In this incident, a ripening room was filled with bananas at about 10:00 A.M. At about 11:00 A.M. there was a violent explosion in the ripening room that killed one nearby worker and seriously injured another. The facility was destroyed.



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Following the explosion, both a high-pressure ethylene cylinder and an ethylene generator were found in the ripening room where the explosion originated. The worker who put the bananas into the room said the high-pressure cylinder was empty and therefore he put the ethylene generator into the room.



**Ethylene Cylinder**



**Ethylene Generator**

Chemaxx was asked to determine the contribution of the ethylene generator to this explosion. The investigation included the determination of the room size, the experimental determination of the displaced volume of a case of bananas and the rate at which ethylene can be generated from ethanol-to-ethylene converter. The maximum amount of ethanol used in the generator is 2 quarts.

The investigation proved, beyond any doubt, that even if the entire 2 quarts of ethanol were instantly converted into ethylene (or gaseous ethanol) it was theoretically impossible for the catalytic converter to provide the fuel needed for the explosion. The maximum concentration of ethylene or ethanol possible from the converter was 1.52% whereas the LELs for ethylene and ethanol are 2.7% and 3.3% respectively. Therefore, regardless of what the banana worker believed, the high-pressure cylinder of ethylene (that he left open) was, most likely, not empty.

The investigation included Dr. Fox sealing himself into an airtight room with an ethylene generator and measuring the gaseous ethylene and ethanol concentrations over a one-hour period. The maximum total concentration of flammable vapors produced in one hour was 0.36% - far below the level needed for an explosion.

Experiments were also conducted to measure the release rates from high-pressure cylinders of ethylene. These measurements were then compared to actual usage rates

and testimonies about usage rates to show that the testimonies underestimated the actual usage rate.

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Dr. Fox is an explosion expert, fire expert, and chemical expert with extensive experience in OSHA, EPA and DOT chemical regulations and chemical safety.

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